

Plastic pellet pollution on the Scheldt riverbank: A case study along the Scheldt estuary between Vlissingen (Netherlands) and Melle (Belgium)

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The world's future is threatened by a triple planetary crisis of climate change, biodiversity loss and pollution. Plastic pollution is increasingly threatening ecosystems' health. The release of plastics to the environment is linked to various consequences for biota and is a major concern for policy makers. Since the 1970s the widespread presence of industrial plastic pellets (nurdles), with dimensions between 25 and 50 mm, have been observed in surface waters and beaches all over the world. These findings raised concerns about the potential environmental impacts of plastic pellets.

We present a case study along the Scheldt estuary, encompassing the port of Antwerp, which is a large polymer hub for production, handling and distribution of industrial plastic pellets. Beginning decades ago, plastic pellets are being unintentionally released into the environment from many locations within the port area and find their way to the Scheldt river. Measures to prevent pellet releases are being taken, but the problem is still ongoing. Although efforts have been made to evaluate plastic pollution levels in the Scheldt estuary, data to evaluate plastic pellet pollution in particular and a harmonized sampling methodology to measure pellet concentrations on the estuary's riverbanks, with its great diversity in occurrence and heterogeneity in landscape, are lacking.

To elucidate the environmental fate of the released plastic pellets, an extensive monitoring was set up. Pellets were manually sampled on 28 locations along the Scheldt riverbank between Vlissingen and Melle in February and March 2024, using a 50 by 50 cm quadrat. To cover the heterogeneity of the pellet concentration, at each location 9 replicates were taken in a standardized manner. All the loose surface materials within the quadrat were collected and air dried in the lab before handling. Plastic pellets were separated manually and counted.

The spatial distribution of the number of pellets on the riverbanks revealed that most pellets were found in the Antwerp port area (on average 3,352 pellets per m²). Upstream from the port (314 pellets per m²) more pellets were found compared to the locations downstream from the port (110 pellets per m²). Significantly more pellets were found on locations close to a physical barrier (e.g. a bridge, a quay, an unnatural bulge of the bank, ...) (Mann-Whitney U test, $p < 0.001$), located in the outer bend or on a straight part of the river (Kruskal-Wallis test, $p < 0.001$), oriented in Southern, Western or Southwestern wind direction (Kruskal-Wallis test, $p < 0.001$), with a surface other than a flat sandy beach (Kruskal-Wallis test, $p < 0.001$) and on locations with high or very high vegetation (Kruskal-Wallis test, $p = 0.002$).

Fourier-transform infrared spectroscopy was used to determine the polymer type of the pellets, revealing that most pellets consisted of polyethylene and polypropylene. The images obtained by stereomicroscopy, confocal microscopy and scanning electron microscopy revealed changes in colour and breakdown of the surface of pellets.

Insights into the magnitude and spatial distribution of plastic pellet pollution on the Scheldt riverbanks provide an estimate of the fate of the port of Antwerp's plastic pellets. The results are relevant for decision making policy and design of management strategies. The easy sampling methodology provides opportunities to scale up or standardize monitoring campaigns, also in a non-marine environment, which could improve the knowledge about plastic pellet occurrence and its potential ecological risk worldwide.

Keywords

Industrial Plastic Pellets; Nurdles; Scheldt Estuary; Riverbank; Pollution; Monitoring Campaign; Standardized Sampling Methodology